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(56) Documents cited

GB A	2094647	US	4138106
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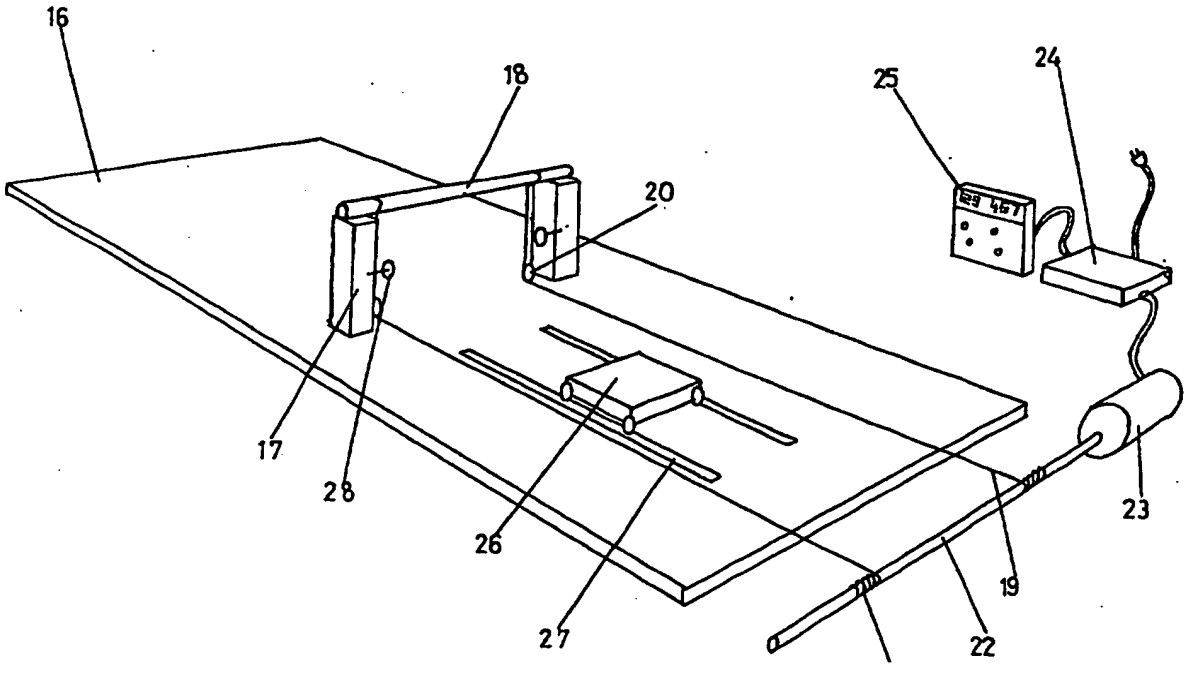
EP	0060302	US	3869121
WO	8000124		

(58) Field of search
A6M

(54) **Electrically controlled exercise apparatus**

(57) The apparatus comprises user interface means such as bar 18 connected via cables 19 to a drive shaft 22 and electric motor 23, the motor being connected to a constant current unit 24 which is connected to the mains supply and to a control and display unit 25, there being also electronic means of controlling the voltage applied to the motor field windings, velocity and displacement sensing means, user adjustment means, an adding means, and means for determining the work done and multiples thereof and displaying them. The user is able to adjust the electronic circuitry to enable an infinitely variable range of weights to be both statically and dynamically simulated and to enable different types of exercise, for example rowing exercises utilising trolley 26, to be simulated.

FIG 2



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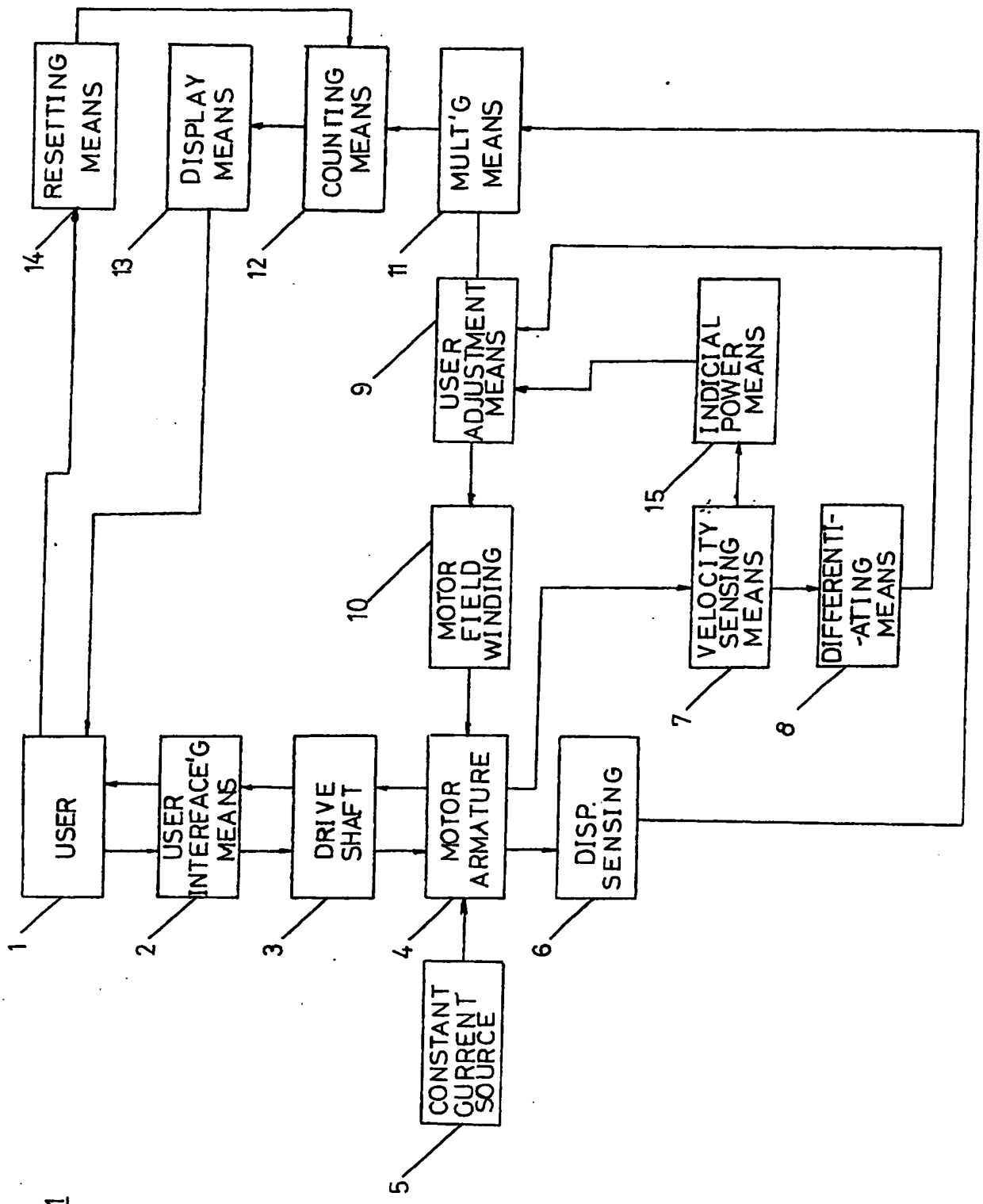
RESETTING MEANS
DISPLAY MEANS
COUNTING MEANS
MULT'G MEANS
USER ADJUSTMENT MEANS
INDICIAL POWER MEANS
MOTOR FIELD WINDING
VELOCITY SENSING MEANS
DIFFERENTI-ATING MEANS
USER
USER INTERFACE'G MEANS
DRIVE SHAFT
MOTOR ARMATURE
DISP. SENSING
CONSTANT CURRENT SOURCE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIG 1

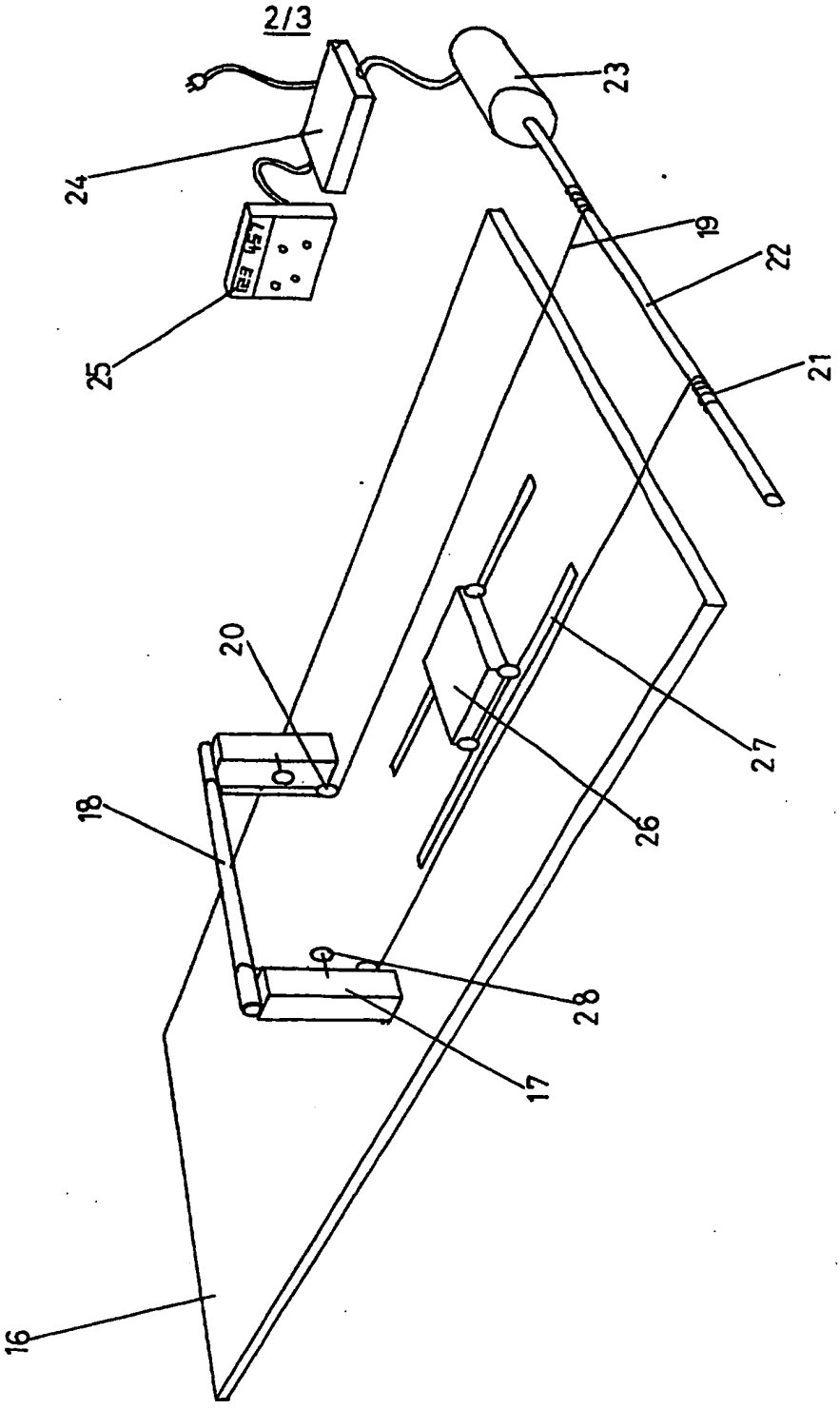

FIG 2

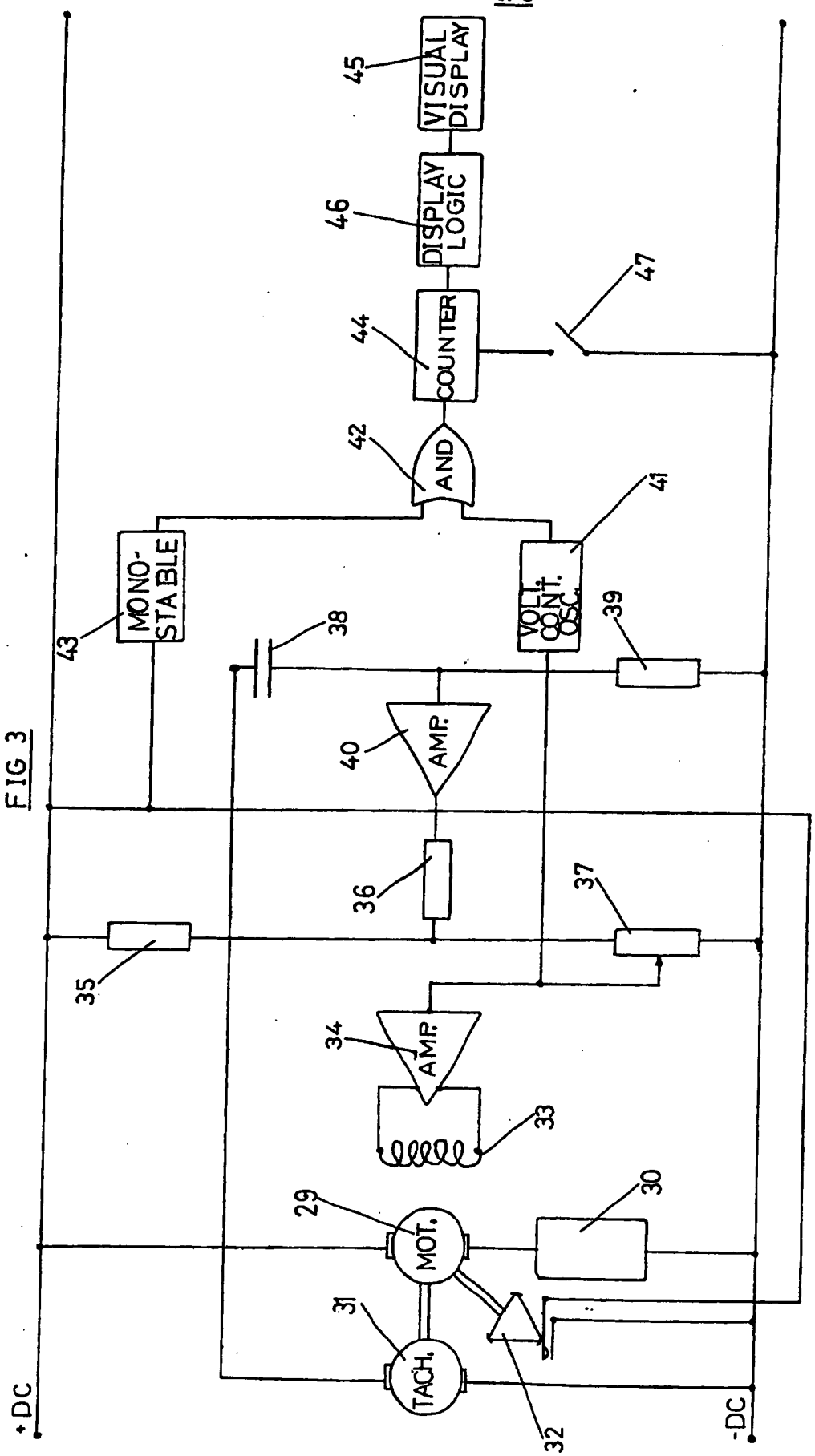
VISUAL DISPLAY
45
DISPLAY LOGIC
46
COUNTER
44
47
AND
42
41
MONO-STABLE
43
VOLT. CONT. OSC.
38
39
AMP.
40
36
37
35
AMP.
34
33
MOT.
29
30
31
TACH.
32
+DC
-DC

FIG 3

SPECIFICATION

Electrically controlled exercise apparatus

This invention relates to exercise or weight training apparatus, especially an apparatus in which the effect of lifting weights or of other exercise is electrically simulated and the work done and other parameters are displayed to the user.

Various devices have been proposed to provide an electrical means of resistance to replace the springs, weights and other such devices in a conventional weight training or exercise apparatus. It has previously been proposed to employ a generator as a means of resistance. This is unsuitable for weight simulation as no force is applied to the user when the user interfacing means is stationary. Such devices are difficult to regulate as may be required for example to simulate the inertial effects of accelerating a weight or to change to a different type of exercise, for example from a weight lifting to a rowing exercise. Other devices have been proposed to give the user a direct indication of the food calories consumed during the exercise period. In such devices the user interfacing means is usually a bicycle and a generator is used as a resistance means. Use of a generator not separately excited requires that the work done by the user be measured by the drop of the output voltage across a resistor.

According to the present invention there is provided an exercise or weight training apparatus comprising a user interfacing means, an electric motor, a connection between the user interfacing means and the electric motor, a motor field winding, a velocity sensing means, a displacement sensing means, a user adjustment means, an adding means, an electronic means of controlling the voltage applied to the motor field windings, and an electronic means of determining the work done and multiples thereof and displaying them to the user.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a functional block diagram of an exercise system embodying the principles of the invention;

Figure 2 is a perspective view of an exercise or weight training apparatus embodying the principle of the invention;

Figure 3 is a simplified schematic diagram of the electrical and electronic portion of the apparatus shown in Figure 2.

Figure 1 shows a functional block diagram of a weight training or exercise system embodying the principles of the invention. The user 1 is coupled via the user interfacing means 2 and the drive shaft 3 to the motor armature 4. The motor armature 4 is supplied with current by a constant current device 5. Displacement of the motor armature 4 is sensed by the displacement sensing means 6 and velocity by the velocity sensing means 7. An output of the velocity sensing means 7 is differentiated with respect to time by the differentiating means 8 and taken to an input of the user adjustment means 9. An output of the user adjustment means 9 is taken to the motor field windings 10.

In one mode of operation of an apparatus embodying the principles of the invention the user 1 adjusts the user adjustment means 9 so that the motor field windings 10 are energised such that a torque is produced by the motor armature 4 on the drive shaft 3 which in turn produces a force on the user interfacing means 2 corresponding to the force produced by gravity on the weight which the user 1 desires to simulate. As the user 1 accelerates the motor armature 4 via the user interfacing means 2 and the drive shaft 3 the differentiated output of the velocity sensing means 7 is added to an output from the user adjustment means 9 and applied to the motor field windings 10 so that the torque on the drive shaft 3 and hence the force on the user interfacing means 2 corresponds with the inertial effects of lifting the simulated weight.

Another output of the user adjustment means 9 is multiplied by the output from the displacement sensing means 6 in the multiplying means 11, the output of which is led to the counting means 12 and hence to the display means 13. Multiplying the output from the user adjustment means 9 by the output from the displacement sensing means 6 enables the work done per unit displacement to be calculated. The sum of the work done is calculated in the counting means 12, and displayed to the user 1 by the display means 13. The user 1 may reset the counting means 12 to zero by the use of the resetting means 14 at the end of the desired exercise period.

In another mode of operation of an apparatus embodying the principles of the invention an output of the velocity sensing means 7 is taken to the input of the raising to indicial power means 15, the output of which is taken via the user adjustment means 9 to the motor field windings 10. The effect of employing this mode of operation is to apply a resistance to the user 1 proportional to an indicial power of the armature velocity. This feature could be used, for example, to give a sensibly isokinetic resistance. Other modes of operation will no doubt suggest themselves to those skilled in the art, for instance the output from the displacement sensing means 6 might be taken to an input of the raising to indicial power means 15 so that varying resistances could be applied to the user 1 at different positions of the user interfacing means 2.

Figure 2 shows one possible arrangement of an exercise or weight training apparatus embodying the principles of the invention. On a bedplate 16 stands supports 17. A bar 18 rests on the supports 17. The bar 18 is coupled via cables 19 and pulleys 20 and pulleys 21 to the drive shaft 22. The drive shaft 22 is connected to the armature of the motor 23. The motor 23 is connected by electrical cables to a constant current unit 24 which is connected to the mains supply and also to a control and display unit 25

the bar 18. He lifts the bar 18 thus turning the motor 23 via the cables 19 and the drive shaft 22. Dynamic and static resistance generated by the motor 23 to the motion of the bar 18 can be altered by the user through the agency of the control and display unit 25. Work done and other useful performance data are displayed to the user at the control and display unit 25.

In another mode of operation of the apparatus the user sits on the trolley 26 which runs on wheels in grooves 27 in the bedplate 16. Grasping the bar 18 in his hands with the cables 19 directed over the pulleys 28 he performs a rowing exercise pulling the bar 18 with his arms and rolling the trolley 26 back and forth in the grooves 27. The user selects the type of resistance required to the rowing exercise on the control and display unit 25 and his performance is also displayed thereon. Other modes of operation within the spirit of the invention will no doubt suggest themselves to those skilled in the art.

Figure 3 shows a simplified schematic diagram for the electrical and electronic portion of an exercise and weight training apparatus embodying the principles of the invention. The motor armature 29 is supplied with a sensibly constant current by a constant current device 30 which may be a simple high value resistor or a more complex but well known electronic circuit. The armature 29 is mechanically connected to or integral with a tachometer 31, which may be a direct current generator, and a cam switch 32. The tachometer 31 generates an output voltage which is proportional to the velocity of the armature 29. The cam switch 32 provides one or more openings of the switch for each revolution of the motor armature 29. Control of torque, speed and direction of rotation is controlled by the magnitude and direction of current passing through the motor field windings 33. Current is passed through the motor field windings 33 from the balanced output of the amplifier 34.

Simulation of the steady force generated by gravity on a weight is achieved by the resistor network 35, 36, and 37. Adjustment of the potentiometer 37 allows the user to adjust the simulated weight to the desired mass. Simulation of the inertial effect of a weight accelerating is provided by electrical differentiation with respect to time by the capacitor 38 and the resistor 39. The differentiated voltage is added to the voltage simulating the effect of gravity on the weight via the amplifier 40 and resistors 36 and 37. Adjustment of the potentiometer 37 therefore provides adjustment for both gravitational and inertial simulation of a range of weights. Component values are chosen for compatability with the particular motor and amplifier characteristics. Other possibilities, such as the provision of additional electronic circuitry to give a resistance to the user proportional to some power of the armature velocity will suggest themselves to those skilled in the art and could be readily incorporated into an apparatus embodying the principles of the invention.

The work done measuring and indicating part of the invention operates by multiplying the motor torque as inferred from the input voltage to amplifier 34 by the displacement of the motor armature 29 as sensed by the cam switch 32. One method of achieving this is to take the input of the amplifier 34 in parallel to the input of a voltage controlled oscillator 41. The number of output pulses per unit time from the oscillator 41 is proportional to the input voltage and hence motor torque and is fed to one of the inputs of the AND gate 42. The cam switch 32 is opened one or more times per motor revolution. Each switch operation triggers the single shot multivibrator 43 which provides an output pulse of fixed duration. The output of the multivibrator 43 is taken to one of the inputs of the AND gate 42. The AND gate 42 is so arranged that output pulses from the voltage controlled oscillator 41 can only appear at the AND gate 42 output for the duration of the pulse from the single shot multivibrator 43. The number of pulses at the output of the AND gate 42 is therefore proportional to the product of motor displacement and field current flow occurring between openings of the cam switch 32.

The internal arrangement of the voltage controlled oscillator 41 is such that the output frequency is approximately linear with respect to input voltage and that no output is generated when the input voltage is zero or negative such as would be the case when no work is done by the user during periods of dynamic overshoot of the simulated weight.

The number of output pulses from the AND gate 42 is counted by the counter 44 and indicated on the display unit 45 via the display logic 46. By the use of suitable logic circuitry in the display logic 46, embodying well known principles, the display can be made to indicate the work done in any convenient units, and by the use of suitable scaling factors can be made to indicate approximately the number of food calories consumed during exercise by the user of the apparatus.

By the use of the basic arrangements described above other configurations are possible using well known techniques, for example supplementing the visual with an audio output and the provision of novel effects such as a low gravity environment simulation or the provision of other relationships between user input means velocity and resistance. If a multilobed cam switch 32 or similar device were employed speed indication by monostable multivibrator 43 output could be employed. A linear motor could be employed as a means of resistance instead of a rotating motor.

CLAIMS

1. An exercise or weight training apparatus comprising:
a user interfacing means
an electric motor
a connection between the user interfacing means and the electric motor
a motor field winding

a velocity sensing means
a user adjustment means
an adding means
electronic means of controlling the voltage applied to the motor field windings
electronic means of determining the work done and multiples thereof and displaying them to the user.

2. The exercise or weight training apparatus of Claim 1 where the output from the velocity sensing means is differentiated with respect to time and added in the adding means to the output voltage from the user adjustment means such that static and dynamic weight simulation is achieved.

3. The exercise or weight training apparatus of Claim 1 where the output from the velocity sensing means is raised to some indicial power and added to the in the adding means to the output voltage from the user adjustment means such that the effects of different exercises are simulated.

4. The exercise of weight training apparatus of Claim 1 where the output from the velocity sensing means is multipled by some constant selected by the user and added to the output from the user adjustment means.

5. The exercise or weight training apparatus of Claim 1 where the output from the displacement sensing means is multiplied by the output from the user adjustment means, to compute the work done per unit displacement.

6. The exercise or weight training apparatus of Claim 1 where the cumulative total of work done is computed by a counting means and a resetting means wereby the user may reset the cumulative total to zero at the end of the period of exercise.

7. The exercise or weight training apparatus of Claim 1 where the cumulative work done computed in Claim 6 is displayed to the user in the display means in convenient units or work or multiples thereof.

8. The exercise or weight training machine of Claim 1 where the velocity of the motor may be calculated from the output of the displacement sensing means.

9. The exercise or weight training apparatus of Claim 1 where the electric motor may be either of the linear or rotary type.

10. The exercise or weight training apparatus substantially as described herein with reference to Figures 1—3 of the accompanying drawings.

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